U.S. Fish & Wildlife Service Susquehanna River American Shad (*Alosa sapidissima*) Restoration: Potomac River Egg Collection, 2010

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Abstract

During April and May, 2010 we used monofilament gill nets to collect 2151 adult American shad from the Potomac River (rkm 150). The purpose of sampling was to supply fertilized eggs to Pennsylvania's Van Dyke American Shad Hatchery in support of Susquehanna River American shad restoration efforts. Sampling took place over a total of 21 days and supplied a total of 375 L of American shad eggs (17.8 million) with a 39% fertilization rate resulting in 6.9 million viable eggs. The U.S. Fish and Wildlife Service's fifth attempt to deliver eggs for Susquehanna River American shad restoration resulted in a much higher number of viable eggs than in previous years.

Introduction

American shad (*Alosa sapidissima*) are an anadromous pelagic species ranging from Labrador to Florida, along the Atlantic coast (U.S. Fish and Wildlife Service 2006). American shad are the largest of the clupeids native to North America (Stier and Crance 1985) and an important planktivore and prey species for bluefish (*Pomatomus saltatrix*) and striped bass (*Morone saxatilis*) (U.S. Fish and Wildlife Service 2006). American shad return to their natal river to spawn after four to six years at sea. Spawning movements follow a latitudinal cline and although variable, spawning generally peaks from 14 to 21 ^{o}C (Stier and Crance 1985). Generally, April is the peak spawning month for American shad in the Potomac River.

Shad were a valuable resource for Native Americans and have been economically important since European colonization of North America. In Pennsylvania, American shad are said to have once ruled the waters of the Susquehanna River and its tributaries (The Native Fish Conservancy 2005). However, American shad have undergone population fluctuations as a result of anthropogenic effects. Initial population declines resulted from commercial harvest coinciding with increases in human population and gear efficiency. Habitat loss (damming) and degradation (pollution) followed and remain significant challenges to restoration. Attempts to mitigate dam effects on American shad and other Susquehanna River species began in 1866. In that year Pennsylvania drafted an Act, which directed dam owner/operators to maintain fish passage structures (The Native Fish Conservancy 2005). The Act established a commissioner's office that evolved in to the Pennsylvania Boat and Fish Commission (The Native Fish Conservancy 2005).

The U.S. Fish and Wildlife Service (Service) is partnered with state, Federal, and hydro-power companies, through the Susquehanna River Anadromous Fish Restoration Cooperative to restore American shad to the Susquehanna River and its tributaries. The Service's current Potomac River egg harvest operation is part of this, nearly forty year, multi-agency restoration effort. The Service's Maryland Fishery Resources Office's role is to deliver viable American shad eggs to the Van Dyke American Shad Hatchery near Thompsontown, PA. Once there, the shad eggs are incubated until hatching and larvae are grown and marked before stocking into the Susquehanna River drainage.

Study Area

The Potomac River is approximately 1.5 km wide at Marshall Hall, MD (rkm 150), where American shad gill netting occurs. The collection site is bounded by Dogue Creek (North) and Gunston Cove (South) and has long been linked to shad harvest and culture. Bottom habitat is characterized by an abrupt transition from the deep channel (≈ 18.3 m) area to relatively shallow depths (≤ 3.5 m). Channel substrate consists of firm sandy mud with intermittent shell. Sand increases in the shoal area forming a comparatively harder substrate.

Materials and Methods

Two Service boats with a crew of three each, fished for American shad nightly. We used two different types of net in 2010 egg collections. One net was used for targeting ripe females and the other was used for targeting ripe males. The net used to target females was 6.1 m deep by 91.4 m long floating monofilament gill net with 14.0 cm stretch mesh panels. The net used to target males was 5.2 m deep by 91.4 m long floating monofilament gill net with 11.7 cm stretch mesh. Up to four nets per boat were

joined in series and drifted parallel to shore in water depths ranging from approximately 7.6 to 16.8 m. Gill nets were set shortly before the evening's slack tide and fished approximately 45 minutes. Fishing was timed so that the nets' drift stalled parallel to a sharply defined shoal area where depth abruptly decreased to less than 4.0 m.

Tidal condition (transitioning high or low) was noted and surface temperature (^{o}C), dissolved oxygen (mg/L), conductivity (microsiemens) and salinity (ppt) were recorded (Yellow Springs Instruments Model 85) each night gill nets were set (Figure 1). The number of running, green, or spent female American shad, ripe male American shad, and bycatch were recorded (Table 1, Figure 2). Gill net effort was recorded but varied since the goal was to maximize catch during each sampling event. Catch per unit effort (CPUE) was calculated as daily combined male and ripe female catch per total hours fished per total net square footage (CPUE= (n/hr/ft^2)). All CPUE values were multiplied by 1000 as a scalar for data display (Figure 1). A subsample of American shad otolith samples, total length (nearest mm) and weight (nearest 0.1 gram) were taken from American shad captured. The samples were taken as a permit requirement of the Potomac River Fisheries Commission.

Results

During spring 2010 we sampled the Potomac River a total of 21 days from April 1- May 5. During the 21 days of fishing we collected ≥ 5.0 L of eggs 16 times (76%). We shipped a total of 375 L (Range = 3.5 – 51.1 L, $\bar{x}$ = 18.8 L/shipment) of eggs from the Potomac River (M. Hendricks, pers. comm.). The overall egg viability was 39%, although daily shipments had a range of 0.0 – 58.3% (M. Hendricks, pers. comm.).

Gill net sampling produced 5,682 fish from the Potomac River, representing thirteen fish species from eight families (Table 1). In 2010, ripe females were more common than green females with a 1.45:1 ratio, but males were more common than ripe females with a 1.3:1 ratio (Figure 2).

From early April to early May, surface water temperature was consistent and dissolved oxygen displayed a slight descending trend on the Potomac River. However, during the first week of May there was a sharp increase in surface water temperature (Figure 1). Surface water temperatures ranged from 16.5 to 22.2 ^{o}C ($\bar{x}$ = 18.4 ^{o}C) while dissolved oxygen ranged from 8.6 to 12.3mg/L ($\bar{x}$ = 10.7 mg/L) (Figure 1). CPUE for shad was variable and there was no apparent relation to tide or to lunar cycle. The CPUE was the highest on the eleventh day (4/20/2010) of sampling (0.003/hr/ft^2) and lowest on the second day (4/7/2010) of sampling (0.00007/hr/ft^2). The highest average value of CPUE was between the eleventh day (4/20/2010) and thirteenth day (4/22/2010) of sampling. During this time the CPUE ranged from 0.0026/hr/ft^2 to 0.0031/hr/ft^2 with an average of 0.0027/hr/ft^2 (Figure 1).

Discussion

American shad harvest in numbers sufficient enough to yield egg shipments was constant on the Potomac River. The greatest numbers of ripe/running male and female American shad were caught between surface water temperatures of 16.5-17.2 ^{o}C as opposed to 2009 sampling when the greatest numbers of ripe/running male and female American shad were collected between water temperatures were of 17.6 – 20.3 ^{o}C. Overall the ratio of ripe male to running female was about 1.25:1. In contrast to other years, males were caught continuously throughout the spawning season (Table 2).

Catching males throughout the entire sampling season can be directly attributed to using a smaller mesh gill net during the 2010 season. In the Potomac River males are substantially smaller than females. To collect a higher number of males, we set at least one smaller mesh gill net (11.75 cm) along with up to eight of the larger mesh gill net (14 cm stretch mesh "female" nets). The smaller mesh nets were used in an effort to keep the sex ratio consistent with one male to two females throughout the entire season. Constant availability of sperm was expected to increase overall egg viability, thus resulting in more fry to be stocked into the Susquehanna River watershed. However, we did not see an increase in viability in 2010 with increased availability of male shad throughout the season.

Conclusion

The Service's fifth attempt to harvest eggs from the Potomac River for delivery to the Van Dyke American shad hatchery, in support of Susquehanna River restoration, was our most successful year. The USFWS provided Pennsylvania with 375 L of eggs, with an overall viability of 39% (6,874,612 viable eggs) (Table 3). Stable river flows and constant water temperature made collection of viable eggs more efficient than in previous years. Collections in 2010 resulted in the highest number of viable eggs since the program began. However our 2010 viability of 39% is identical to our five year average since Potomac River egg collection began in 2006.

Project Summary

Over the past five years the USFWS has provided Pennsylvania with over 17 million viable shad eggs.

Year	Volume (L)	Viable Eggs (N)	Viability (%)
2010	375.0	6,874,712	39%
2009	132.2	1,885,500	30%
2008	194.4	3,491,069	41%
2007	183.9	2,875,455	42%
2006	99.3	2,003,222	44%

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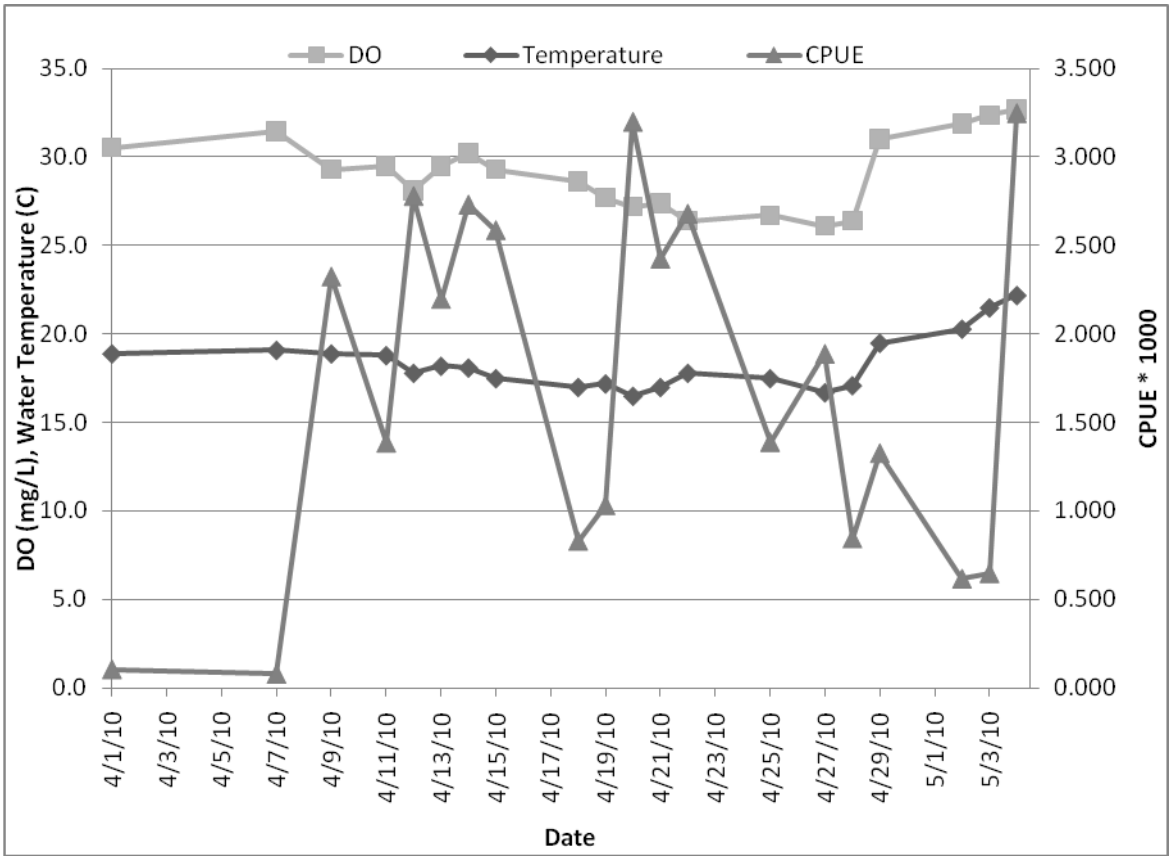

Figure 1. Spring 2010 American shad catch per unit effort, surface dissolved oxygen, and surface temperature, by sample date, for the Potomac River at Marshall Hall, MD. Surface salinity (not depicted) was always ≤ 0.10 ppt.

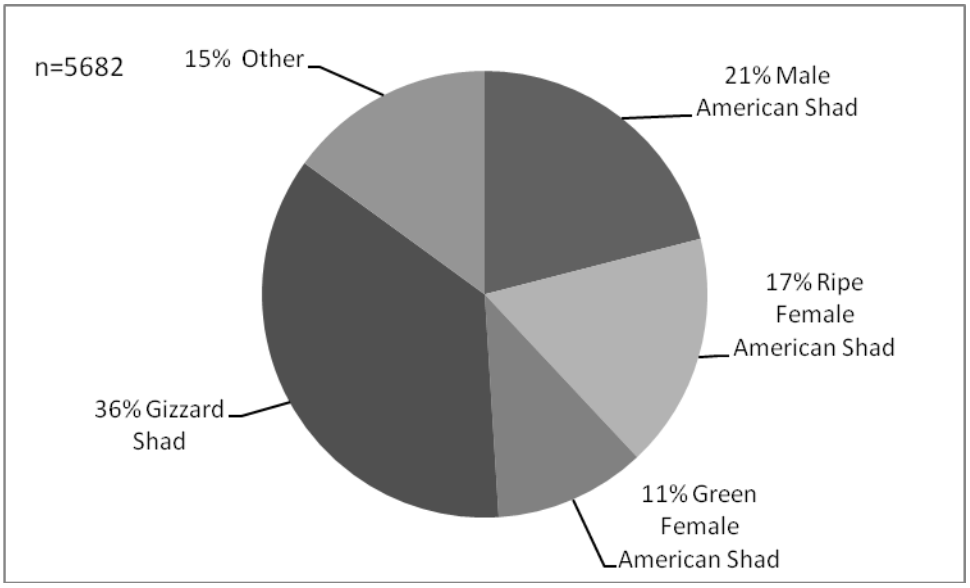

Figure 2. Spring 2010 species composition from Potomac River gill net sampling at Marshall Hall, MD. Other species and number caught listed in Table 1.

Table 1. List of species and number collected in gill nets from the Potomac River during spring, 2010.

Family	Scientific Name	Common Name	Number Captured
Catostomidae	*Carpiodes cyprinus*	quilback sucker	8
Centrarchidae	*Micropterus salmoides*	largemouth bass	1
Channidae	*Channa argus*	northern snakehead	1
Clupeidae	*Alosa mediocris*	hickory shad	1
	Alosa sapidissima	American shad	2767
	Brevoortia tyrannus	Atlantic menhaden	1
	Dorosoma cepedianum	gizzard shad	2040
Cyprinidae	*Cyprinus carpio*	common carp	4
	Carassius auratus	goldfish	1
Ictaluridae	*Ictalurus furcatus*	blue catfish	313
	Ictalurus punctatus	channel catfish	21
Lepisosteidae	*Lepisosteus osseus*	longnose gar	18
Moronidae	*Morone saxatilis*	striped bass	506

Table 2. American shad catch totals with respect to male and female ratio and the associated viability and liters of eggs produced during spring, 2010.

Date	Ripe Male	Running Female	Ratio Male:Female	Liters	Viability
4/1/2010	2	0	0		
4/7/2010	3	1	3:1	0.0	0
4/9/2010	83	14	5.9:1	3.5	0
4/11/2010	22	31	1:1.4	13.6	48.1
4/12/2010	92	53	1.7:1	16.8	47.4
4/13/2010	77	17	4.5:1	10.3	41.8
4/14/2010	97	9	10.7:1	0.0	0
4/15/2010	66	50	1.3:1	21.0	41.8
4/18/2010	17	29	1:1.7	15.7	53.1
4/19/2010	21	68	1:3.2	37.6	35.4
4/20/2010	129	124	1:1	51.1	24.1
4/21/2010	148	107	1.4:1	48.5	35.1
4/22/2010	95	58	1.6:1	18.0	48
4/25/2010	55	51	1.1:1	25.7	43.3
4/27/2010	58	80	1:1.4	29.9	29.8
4/28/2010	18	26	1:1.4	9.7	35.2
4/29/2010	67	25	2.7:1	12.8	58.3
5/2/2010	11	29	1:2.6	10.2	0
5/3/2010	13	33	1:2.5	0.0	0
5/4/2010	86	114	1:1.32	41.3	51.9
5/5/2010	36	36	1:1	9.3	37.4

Table 3. 2010 Shipment and viability summary for American shad eggs, delivered to the Van Dyke Hatchery from various collection sites(Hendricks 2010, unpublished).

Site	Shipments (N)	Volume (L)	Eggs (N)	Viable Eggs (N)	Viability (%)
Potomac R.	17	375.0	17,843,432	6,874,712	39%
Delaware R.	9	85.6	4,613,799	1,936,302	42%
Susquehanna R.	8	115.3	7,344,503	1,334,705	16%
Total	34	575.9	29,801,734	10,145,719	33%